

## Cost comparison – Wind turbine installation onshore and offshore

In 2020, Rystad Energy performed a study which concluded that it is more cost effective to install 14 MW wind turbines compared to 10 MW wind turbines as part of a 1 GW offshore windfarm – including all infrastructure. The report is available online.

Considering the plans of the Danish consortium Green Power Denmark, and the lobbyism of countless stakeholders at the government of Denmark to build more wind turbine test centers onshore, it is worth looking at the cost impact, and Government money spending. The definition of a prototype wind turbine is a “series 0”. This estimation is to provide a brief cost assessment of series 0 turbine installation onshore versus offshore.

The Rystad Energy report and cost data provide a solid basis to compare relative installation costs for wind turbines offshore. In 2020 DTU has published a report on the Østerild wind turbine test center with a cost breakdown (2010) and lessons learned. These two data sources along with complementarity sources to perform an estimated cost calculation are utilized for the present calculation.

<b>Offshore (Rystad)</b>	Total Cost (bn USD)	Cost per wind turbine (mm USD)
1 GW windfarm (10 MW wind turbines)	2.7	27.00
1 GW windfarm (14 MW wind turbines)	1.93	27.16
Difference	-28.5%	+0.6%

<b>Onshore test-site (Østerild)</b>	Total Cost (mm USD)	Cost per wind turbine (mm USD)
9 x test-site (for a 14 MW wind turbine)	250.11	27.79

Looking at the cost breakdown above, it is evident that building a new onshore test-site would cost more per series 0 wind turbine than if the same series 0 wind turbine would be installed offshore – if it would be part of an existing or to-build development. Looking at the total cost of a 1 GW commercial offshore wind farm with 100 x 10 MW turbines, the option to install 99 wind turbines and replace one commercial wind turbine with a series 0 wind turbine would cost 163.000,00 USD, or 2.25% of the cost of the same series 0 wind turbine installed onshore. If the series 0 wind turbine would be installed in addition to 100 x 10 MW, so the series 0 would be wind turbine number 101, it would cost 630.000,00 USD less than building it onshore as part of a test-site.

For correct reasons, the general public and many politicians are informed by experts and specialist advisory bureaus that an offshore wind farm development is more expensive than an onshore windfarm. The latter is true for commercial developments only. However, one needs to compare apples with apples - a commercial wind farm development is not the same as a wind turbine test-center, neither offshore nor onshore.

It looks to be a misleading claim by experts and specialist advisory bureaus that that building series 0 wind turbines offshore is the most expensive option - as per the cost data above, this is not necessarily true.

The government (and Ørsted as being a majority government owned energy company) need to take the opportunity to more efficiently utilize the already established wind farms offshore and those that are tendered for as new developments. After all, the already established offshore wind farms and those in development include the entire package needed, also for series 0 wind turbines to be build and tested for a relatively low cost. Former and latter development packages include but are not limited to; permit applications, engineering, fabrication of the substation(s) and turbines, installation, electricity grid connection, operation, monitoring, maintenance and eventually decommissioning. All costs associated with the entire life cycle of a wind farm are estimated prior to tendering for permits at the government.

Regulations for installation of series 0 wind turbines should therefore be included by the government in offshore tender processes. In other words; each new commercial offshore windfarm development should include (a numer of) dedicated foundations on which series 0 wind turbines can be installed and be a part of the infrastructure of said commercial wind farm. Flexibility could be included such that future series 0 wind turbines could be installed on those same foundations.

The present calculation only looks at the cost comparison of test wind turbine installation onshore and offshore. Any other costs that may be associated with installation, compensation costs for instance, are not included.

#### Sources:

Rystad Energy: Less is More If Using 14 MW Turbines

Guidetoanoffshorewindfarm: <https://www.thecrownestate.co.uk/media/2860/guide-to-offshore-wind-farm-2019.pdf>

DTU: Østerild Test Center: Lessons Learned in Setting up a Wind Test Center for Offshore Wind Energy

Sources: Rystad, Guide to onshore wind farm, Energi styrelsen

## Turbines

MW	Turbine million USD	Foundation million USD	Installation foundation million USD	Installation Turbine million USD	Total cost turbine million USD	Cost for Turbines in Billion USD for 1 GW windfarm	# turbines needed	Total cost windfarm per turbine million USD	Total cost windfarm per Billion USD (at 2.7 million USD per MW)	Total cost 1 GW windfarm billion USD	Cost Offshore Windfarm per windturbine million USD	Total cost % per windturbine on total windfarm cost	Windfarm costs excluding windturbines (infrastructure/substation etc) billion USD
10	8	4	1.5	1	14.5	1.45	100	27	27	2.7	27,000	1.00%	1.25
12	10.1	4	1.5	1	16.6	1.38	83	32.4	27	2.25	27.1	1.20%	0.87
14	12.3	4	1.5	1	18.8	1.34	71	37.8	27	1.93	27.163	1.41%	0.59

## Test Site Østerild

Cost per test site 2010 million USD	9 test sites million USD	Rent per test site million USD	Tests by DTU 6 per year million USD	Cost of 1 windturbine onshore million USD	Installation cost per windturbine onshore million USD	Total cost for windturbine testsite onshore with 14 MW windturbine installed million USD
3.5	31.5	1	0.85	18.8	3.64	27.79

## Conclusion

Cost of installation of 1x 14 MW windturbine onshore 27.8  
 Cost of installation of 1x 14 MW windturbine offshore 27.2 2.23%

NB: If a test windturbine of 14 MW is installed as part of a planned 1 GW development offshore with 10 MW windturbines, the cost of 1x 14 MW test windturbine would be USD 162,000 more than a 10 MW windturbine. This would mean the 14 MW test windturbine installed offshore would only cost 2.23% of the total cost of the test windturbine being installed onshore.

0.60% higher cost for a 14 MW windturbine compared to a 10 MW windturbine  
 USD 162,000 extra cost to install 1x 14 MW test windturbine in a windfarm with 100x 10 MW turbines